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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/805,121

03/19/2004

Sanjeev Aggarwal

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TEXAS INSTRUMENTS INCORPORATED

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EXAMINER

MENZ, DOUGLAS M

ART UNIT

PAPER NUMBER

2891

DATE MAILED: 01/24/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/805,121

Applicant(s)

SANJEEV AGGARWAL ET AL.

Examiner

Douglas M. Menz

Art Unit

2891

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 31 October 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-7 and 11-16 is/are pending in the application.
- 4a) Of the above claim(s) 15 and 16 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-7 and 11-14 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 19 March 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Election/Restrictions***

Newly submitted claims 15 and 16 are directed to an invention that is independent or distinct from the invention originally claimed for the following reasons: Claims 15 and 16 are directed to a product by process of a copper interconnect structure.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 15-16 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States

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only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-3 and 11-12 are rejected under 35 U.S.C. 102(e) as being anticipated by Lane et al. (US 6787912).

Regarding claims 1 and 11, Lane discloses a copper interconnect structure, comprising:

A semiconductor substrate (14, Figs. 1,4);

A dielectric layer (12) over the semiconductor substrate (Figs. 1,4 and Col. 3, lines: 5-10);

A trench (10) in the dielectric layer (Figs. 1,4 and Col. 3), it is inherent that the trench comprises a vertical surface and a horizontal surface;

A barrier layer (20) in the trench wherein the barrier layer comprises a material from the group consisting of iridium, ruthenium, rhodium, platinum and palladium (Figs. 1,4 and Col. 3, lines: 50-67), Lane discloses that the barrier layer can be formed by a PVD process (Col. 5, lines: 50-65), as such, it is inherent that the resultant barrier layer would have a horizontal thickness that would be greater than the vertical thickness of the trenches; and

Copper (22) filling the trench over the barrier layer (Fig. 4 and Col. 3, lines: 63-67 and Col. 7, lines: 26-35).

Regarding claim 2, Lane further discloses the structure comprising:

A via (*bottom of 10*) in the dielectric layer (12, Figs. 1, 4 and Col. 4);

A trench in the dielectric layer (10, Figs. 1, 4 and Col. 4) it is inherent that the via and trench comprises a vertical surface and a horizontal surface;

A barrier layer (20) in the via wherein the barrier layer comprises a material from the group consisting of iridium, ruthenium, rhodium, platinum and palladium (Figs. 1, 4 and Col. 3, lines: 50-67), Lane discloses that the barrier layer can be formed by a PVD process (Col. 5, lines: 50-65), as such, it is inherent that the resultant barrier layer would have a horizontal thickness that would be greater than the vertical thickness of the via and trenches; and

Copper (22) filling the via over the barrier layer (Fig. 4 and Col. 3, lines: 63-67 and Col. 7, lines: 26-35).

Regarding claim 3, Lane further discloses wherein the via (*bottom of 10*) is positioned beneath the trench (Figs. 1, 4).

Regarding claim 12, Lane further discloses wherein the barrier layer 20 can have a thickness range from about 3nm to about 15nm (Col. 5). Given the nature of PVD, wherein the thicker portion would be disposed on a horizontal surface and the thinner portion would be disposed on the vertical portion, Lane anticipates a 5:1 thickness ratio.

Claims 4-7 and 13 are rejected under 35 U.S.C. 102(e) as being anticipated by Omstead (US 6713373).

Regarding claims 4 and 13, Omstead discloses a copper interconnect structure, comprising:

A semiconductor substrate (Col. 2, lines: 30-37);

A dielectric layer (304, Figs. 3-8) over the semiconductor substrate;

A trench (312, Fig. 3) in the dielectric layer (Col. 3, lines: 45-50) it is inherent that the trench comprises a vertical surface and a horizontal surface;

A first barrier layer (404, Figs. 4-8) in the trench wherein the barrier layer comprises ruthenium oxide (Col. 3, lines: 50-60), Omstead discloses that PVD is a known deposition technique employed in the art and as such, it is anticipated that the barrier layer can be formed by PVD, which in turn inherently produces a horizontal thickness that would be greater than the vertical thickness of the trenches; and

Copper (704, Fig. 7 and 804, Fig. 8) filling the trench over the barrier layer (Col. 5, lines: 22-40).

Regarding claim 5, Omstead further discloses the structure further comprising:

A via (316, Fig. 3) in the dielectric layer (Col. 3, lines: 45-50);

A trench (312, Fig. 3) in the dielectric layer (Col. 3, lines: 45-50) it is inherent that the via and trench comprises a vertical surface and a horizontal surface;

A first barrier layer (404, Figs. 4-8) in the via wherein the first barrier layer comprises ruthenium oxide (Col. 3, lines: 50-60), Omstead discloses that PVD is a known deposition technique employed in the art and as such, it is anticipated that the

barrier layer can be formed by PVD, which in turn inherently produces a horizontal thickness that would be greater than the vertical thickness of the via and trenches; and Copper (704, Fig. 7 and 804, Fig. 8) filling the via over the barrier layer (Col. 5, lines: 22-40).

Regarding claim 6, Omstead further discloses wherein the via is positioned beneath the trench (Figs. 3-8).

Regarding claim 7, Omstead further discloses comprising a second barrier layer (504, Figs. 5-8) wherein the second barrier layer comprises ruthenium (Col. 4, lines: 15-30).

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Omstead (US 6713373) in view of Lane et al. (US 6787912).

Omstead discloses the structure of claim 13 as mentioned above, however, Omstead does not explicitly disclose a thickness ratio of 5:1. Lane discloses an internconnect structure with a barrier thickness ratio of 5:1 (Col. 5). It would have been obvious to one of ordinary skill in the art at the time of the invention to use Lane's thickness ratio in Omstead's structure as Lane discloses that these thicknesses are common examples in the art (Col. 5).

### ***Response to Arguments***

Applicant's arguments filed 10/31/05 have been fully considered but they are not persuasive. Applicant argues that Lane does not disclose the limitations currently added by amendment. As noted above, this is incorrect. Lane explicitly discloses deposition by PVD, which would inherently produce a barrier layer with a horizontal thickness that would be greater than the vertical thickness in the vias and trenches. Furthermore, Omstead also anticipates deposition by PVD and that it is a non-conformal process.

### ***Conclusion***

**THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within



TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Douglas M. Menz whose telephone number is 571-272-1877. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bill Baumeister can be reached on 571-272-1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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**BRADLEY K. SMITH**  
**PRIMARY EXAMINER**